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# **PRESERVATION OF EARTHEN SITES IN REMOTE AREAS: THE BUDDHIST MONASTERY OF AJINA TEPA, TAJIKISTAN**

Enrico Fodde<sup>1</sup>, Kunio Watanabe<sup>2</sup>, and Yukiyasu Fujii<sup>3</sup>

## **CONTACT DETAILS**

<sup>1</sup>Lecturer

BRE Centre for Innovative Construction Materials  
Department of Architecture and Civil Engineering  
University of Bath  
Bath BA2 7AY  
UK  
Tel: +44 1225 383185  
Fax: +44 1225 386691  
Email: E.Fodde@bath.ac.uk

<sup>2</sup>Professor

Graduate School of Science and Engineering, Saitama University  
255 Shimo-Okubo, Sakura-ku  
Saitama, 338-8570  
Japan  
Tel: +81 48 858 3571  
Fax: +81 48 855 1378  
Email: kunio@mail.saitama-u.ac.jp

<sup>3</sup>Researcher

Fukada Geological Institute  
2-13-12 Honkomagome, Bunkyo-ku  
Tokyo, 113-00021  
Japan  
Tel: +81 3 39448010  
Fax: +81 3 39445404  
Email: fujii@fgi.or.jp

## **ABSTRACT**

The Buddhist monastery of Ajina Tepa is the most significant in central Asia as it was fully excavated by employing updated archaeological methods and extensively documentation. The site is a sophisticated blend of earthen architectural form, sculptural detailing and wall painting decoration which is unique in the area. The site is located in south Tajikistan along the Vahsh valley about 13km east from the modern city of Kurgan Tybe.

The aim of the paper is to give an overview of the UNESCO/Japan Trust Fund project 'Preservation of the Buddhist Monastery of Ajina Tepa, Tajikistan (Heritage of the Ancient Silk Roads)' by making a description of the historical background, main conservation threats, analytical work for the selection of repair material, preparatory work before conservation, documentation activities, and conservation work carried out at the site.

## **KEYWORDS**

Earthen materials, conservation, Buddhist monastery, central Asia, Tajikistan

## **BIOGRAPHIES**

**Enrico Fodde** (MA, PhD) is Lecturer at the BRE Centre for Innovative Construction Materials, Department of Architecture and Civil Engineering, University of Bath (UK). He worked as consultant for the Division of Cultural Heritage (UNESCO Paris), the World Heritage Centre (UNESCO Paris), and the Abu Dhabi Authority for Culture and Heritage (UAE). He was formerly International Project Director of Moenjodaro (Pakistan) and Field Director for several UNESCO projects in Central Asia.

**Kunio Watanabe** (PhD) is Professor at the Graduate School of Science and Engineering, Saitama University (Japan) and director of the Geosphere Research Institute. He is director of the project 'Conservation of the Buddhist Monastery of Ajina Tepa (Tajikistan)' and has previously worked in international conservation projects such as that of Choga Zanbil (Iran) and Otrar Tobe (Kazakhstan).

**Yukiyasu Fujii** (PhD) is Researcher at the Fukada Geological Institute, Tokyo (Japan), where he conducts geological and geographical surveying by employing both fieldwork and photogrammetry techniques. This is the first UNESCO conservation project he joined.

## INTRODUCTION

Central Asia holds a great variety of earthen archaeological sites, most of them located in remote areas. Before the collapse of the Soviet Union archaeological excavations were neither followed by conservation work nor by backfilling, and often work was carried out in haste without any standard documentation<sup>1</sup>. However, the site of Ajina Tapa is unique in the context of Central Asia (Fig 1, 2 and 3). The comprehensive and systematic excavation campaigns were undertaken between 1961 and 1975 under the supervision of Moscow's Institute of Oriental Studies of the Russian Academy of Sciences who employed the most updated excavation and documentation techniques. The wealth of information that was produced is manifest not only in the Russian and English monographs (Litvinskij and Zejmal, 1971 and 2004), but also in the extensive archival material.

The outputs of the UNESCO/Japan Trust Fund for the Preservation of World Cultural Heritage project 'Preservation of the Buddhist Monastery of Ajina Tapa, Tajikistan (Heritage of the Ancient Silk Roads)' are:

- a) Scientific documentation of the site.
- b) Management system to ensure proper functioning and maintenance of the site and preparation of a master plan.
- c) Appropriate conservation work to be implemented and a maintenance schedule put in place.
- d) Promotion of the site amongst members of the local community, as well as at the national and international levels.
- e) Staff to be trained in the management, monitoring, and maintenance of the site.

The project was started in 2005 and will be completed in 2008. It is managed by the UNESCO Cluster Office in Almaty (Kazakhstan) in close collaboration with the UNESCO World Heritage Centre. A national project administrator was appointed to work in the Dushanbe UNDP Office with the scope of facilitating the coordination of the project. National implementation agencies include the Academy of Sciences of Tajikistan (Institute of History, Archaeology and Ethnography, the National Museum of Antiquities), the Ministry of Culture of Tajikistan, and the Tajik Technical University. Several international consultants were included in the project with the aim of training local experts in archaeological cleaning, updated documentation techniques, laboratory analysis, and appropriate conservation methods. The project is part of a wider involvement of UNESCO and the Japan Trust Fund in the conservation of a series of earthen archaeological sites of Central Asia (Fodde 2007a; Fodde 2007b): Fayaz Tapa (Uzbekistan), Chuy valley sites (Kyrgyzstan), and Otrar Tobe (Kazakhstan). The present project should be understood as part of this series.

A house neighbouring the site was selected as a base for the practical conservation work and as accommodation for national and international experts<sup>2</sup>. The house owner was selected as

guardian for the site, his role being useful especially during the winter months when no activity is carried out at the site. A car was purchased as project vehicle and this was essential for transporting both people and conservation materials.

The documentation centre was located in the National Museum of Antiquities of Tajikistan. It was formed by three young trainees from the Faculty of Architecture and Building, Tajik Technical University, whose role was to update the archive. The extensive archival material made available by archaeologist Boris Anatolevich Litvinskij can be divided as:

- a) Architectural (including photographic negatives, original prints, original survey plans, sections, axonometric views, pictures of original drawings, original excavation reports),
- b) Sculptural (photographic negatives, original prints, original excavation reports with description of single sculptures), and,
- c) Wall paintings (original survey drawings, pictures of original drawings, excavation reports).

One of the main outcomes of the work was the digitisation of all the available material and the creation of a permanent database to be used as a reference for future conservators and scholars. File format of digital archiving is jpeg and Excel, and the archive is accessible by appointment with the Museum director.

The documentation centre was provided with fire proof steel cabinets for filing damage assessment and intervention records, for maps, analogue photographs and negative films, and shelves for the storage of reports and literature. After scanning and listing, the original material was properly stored in the cabinets and kept in the documentation centre. This is an essential tool so that any future conservation work is done in collaboration with the documentation centre.

A laboratory for the analysis of earthen material was purchased partly in Europe and partly in Kazakhstan<sup>3</sup>. Setting up was done in the National Museum of Antiquities of Tajikistan where a room was allocated for the purpose. Training on international methods for the analysis of soil as a building and conservation material was carried out with one archaeologist from the Museum and one student from the Tajik Technical University. Training is one of the main components of the project and it was carried out in the form of empirical testing and laboratory analysis, in order to introduce current principles of conservation science and transfer the skills to young conservators and students. Furthermore, the tests proved to be essential for a proper understanding of the behaviour of earthen materials, where soil and historic sample characterisation was necessary to enhance knowledge before physical testing.

One of the final aims of the project will be the completion of the promotional activities programmes, this will include multi-lingual information and sign boards with the history of the monument and a pamphlet with the site map (in Tajik, Russian, English and Japanese).

## HISTORICAL BACKGROUND

Buddhism appeared in central Asia from Afghanistan in the 3<sup>rd</sup> century BC, but it also spread from the routes that ran from north-western India to northern China (McArthur 2002, 19; Fisher 1993, 44). Important bases for the enlargement of Buddhism were the ancient states of Bactria, Parthia, and Sogdia. Buddhism continued to flourish in parts of central Asia until the 11<sup>th</sup> century AD when it started to decline due to the introduction of Islam in the region.

## DESCRIPTION OF THE MONASTERY

Litvinskij and Zejmal (2004, 21) define the monastery of Ajina Tepa as a typical 7th-8th century AD combination of *vihāra* (monastic area) and *caitya* (temple area). In fact the study of the plan reveals that the complex was made of two distinct parts: the monastery (characterised by an open courtyard measuring 19x19m, with *cellae* facing four access elbow-shaped passages, or *īwān*), and the temple (with similar arrangement of four *īwān* facing the cellae, but with a massive terraced stupa in the courtyard). The discovery and excavation of the 13 metre long Buddha in lying position in one of the corridors of the temple area was particularly important for the study of the spread of Buddhism in central Asia (Figs 2 and 4). Depictions of the Buddha in *parinirvanasana* (symbolizing his mortal passing and his last stage from the cycle of rebirth) are widespread in Southeast Asia and Sri Lanka, but are quite rare in central Asia (McArthur 2002, 107). The first attempts to conserve the statue, made of soil, were made in 1961. It was then cut into 92 pieces and transported to the National Museum of Antiquities in Dushanbe (Masov et al 2005, 167). Here it was conserved by a group of experts under the leadership of P.I. Kostrov from the Hermitage Museum in Saint Petersburg and since 2001 is part of the permanent exhibition of the National Museum. After the destruction of the Bamiyan Buddhas in Afghanistan, this is currently the largest statue of the Buddha in central Asia.

Building techniques were well developed in 7th-8th century AD Central Asia. The excavated structures, such as those of Ajina Tepa, give evidence of an impressive building activity that needed specialised craftsmen. It seems possible that rods and strings were used by local builders to lay out the plan, and this is particularly evident by the precision of measurements of some rooms that are an exact square of 7x7m (Litvinskij and Zejmal 2004, 54). It can be suggested here that these craftsmen might have been itinerant because of similarities with other temples (Litvinskij and Zejmal 2004, 54).

## WALLING MATERIAL

Mud brick and *pakhsa* (rammed earth) construction were both employed in the construction of the monastery walls, *pakhsa* being seldom found at the lower wall levels<sup>4</sup>. The general tendency in Ajina Tepa is to find from five to eight courses of mud brick at the base of the wall and several courses of *pakhsa* blocks on top. This is not a traditional method in western Central Asia, but it is rather typical in 5th-7th century AD Bactria and Tukharistan (Litvinskij 1971, 223). Furthermore Litvinskij and Zejmal (2004, 54) explain that this construction method was necessary for allowing the construction of niches at wall base, a simplified task if mud brick is used. Roofing was constructed with barrel vaults, without formwork. It is likely that for

structural reasons vaulting was made with bricks richer in straw, in order to reduce the vertical component of the force. Mud brick cannot take bending or shearing so the vault was built following the catenary, thus eliminating all bending and allowing the material to work only under compression. Walls were plastered with mud plaster (*saman*) in thick layers (Litvinskij and Zejmal 1971, 223; Litvinskij and Zejmal 2004, 56)

The present state of conservation of the site does not allow proper measurement of original dimensions of mud brick and *pakhsa* blocks. However, Litvinskij and Zejmal (2004, 26) explain that at the time of excavation *pakhsa* blocks measured 0.70x0.78x0.80m, and that mud brick measured 0.10-0.12x0.25x0.50m. Other mud bricks surveyed by Litvinskij measured 0.05x0.20x0.50m. Fired brick was found in the core of the stupa and for paving the main courtyard path, these bricks measuring 0.035-0.06x0.31-0.54x0.26-0.40m. It was also found as paving material for two small *cellae* (XXXI and XXXV), for paving stairs and walks, as a cladding material for wall bases, and for doorways (Litvinskij and Zejmal 1973, 223). The Inner walls were 2.2m thick, whilst outer walls were 3.4m. No clear foundation method was employed in Ajina Tepa. Generally speaking a *pakhsa* platform of 15-20cm was built at floor level, whilst in rarer cases a layer of red clay was applied as footing (Litvinskij and Zejmal 2004, 55).

#### **HISTORIC REPAIR METHODS**

The excavation report by Litvinskij contains descriptions of building techniques, but he also found archaeological evidence to suggest that changes and repair work were carried out in several parts of the building, and this is mainly to be attributed to the collapsing of vaults. In some cases decay may have been caused by miscalculations of wall thickness in relation to the load of vaults, with consequential collapse. This is true for Period I of the monastery, and repair and renovation work extended to wall paintings also. Decayed earthen sculptures were sometimes found reused as repair material within the masonry (Litvinskij and Zejmal 2004, 20). More serious structural faults were repaired by adding *pakhsa* buttresses, such as those found in the inner wall of section V.

#### **MAIN CONSERVATION THREATS**

In order to have a general view of the main causes of deterioration, a survey was carried out in 2006 before starting conservation. This indicated the most common symptoms of decay as being: collection of debris at base of wall, appearance of a soft or hard crust of clay, grass growth (some with deep roots), coving (undercutting), animal, insect and human damage, water channels, salts crystallization, cracks, and missing parts of walls. The fact that none of the walls considered in this study was previously conserved adds value to the research because it shows the behaviour of exposed earth walls in a natural environment.

The study shows that the main causes of decay can be broadly classified as: vegetation damage, rheological, man made, and as a result of high contents of soluble salts.

## **VEGETATION DAMAGE**

The site is characterised by a substantial amount of flora which grows between the wall structures and on top of walls (Fig 5). The vegetation is represented by succulent plants, and prickly desert grass, which vary from shallow to deep rooted. It was soon clear that one of the most urgent needs was the management of deep rooted grass that grows on top of structures. This causes serious collapse of structural parts, mainly due to the long and wide root system.

## **MATERIALS DEFORMATION DUE TO WATER FLOW**

Earthen structures are mechanically eroded by water mismanagement, and by the lack of water drainage systems (Fig 6). The lack of capping or sheltering of excavated walls can cause irreversible damage. In addition, washed out soil is often collected at the base of the walls. The patterns of decay produced can be described as discrete erosion channels and general erosion due to rain washing.

## **MAN MADE DECAY**

The most urgent conservation action in Ajina Tapa was damage to the site from visitors, walking on earthen walls and causing damage. Shovel marks were also frequently found on the historic earthen structures as local people tended to use the walls as quarry for mud brick making. In 2006, in order to protect the site from man made decay, a fence of circa 600m was constructed.

In addition, the old pedestrian bridge that led to the site was not safe, due to its advanced state of decay, and it was decided to build a new one (dimensions 1.2 x 14m) to allow safe access to visitors, site staff and conservation materials.

## **SOLUBLE SALTS DAMAGE**

Coving (undercutting) is a typical decay symptom of earthen walls, especially when not supported by a stone plinth. It is the product of the combination of soluble salts rising from the ground which destabilises the earthen material, and of wind erosion (Figs 6 and 7). Salts can effloresce on the surface of the wall base and when this is accompanied by the combined action of wind and windblown silt, the area affected by efflorescence is easily eroded (Fodde 2007c). When this is repeated several times, the section of the wall base can become thinner and eventually lose its load bearing capacity, causing collapse. Direct inspection of several structures of the site showed that the rate of decay was high and urgent conservation work was needed.

## **PREPARATORY WORK**

One of the most useful tools for the management of conservation work was the action plan for the site. This document was continuously updated so that to be used together with the workplan as a reference for the numerous activities of the project.



## **DRAINAGE PLAN**

Before drafting the drainage plan, the site was monitored in the winter and until the wet season (November till March). In so doing, a complete picture was provided by mapping the wet areas. The main information collected was:

- a) rain fall data to understand both the amount of collected water and evaporation rate (heavy storms are carefully studied and the amount of water compared to the rooms capacity),
- b) temperature (especially useful for freeze and thaw cycles),
- c) eventual changes in the ground topography (creation of gullies and drainage channels by rain).

This was carried out through photographic documentation and mapping in the topographic plan. The drainage plan is an essential tool for the removal/redirection of water away from foundations and structures for both inner and outer areas of the site. Monitoring activity should also predict the worst possible case (for example one week of repeated storms). As for drainage work, it is suggested to redirect/disperse water into small catchments, as it seems very unlikely that it could be managed otherwise.

## **STUDY OF LOCAL SOURCES OF CLAY**

Local sources of clay were inspected and samples taken accordingly. Interviews and questionnaires were undertaken with local craftsmen so that to identify the nearest soil quarries. Samples were analysed in the laboratory to assess compatibility with the historic fabric of the monastery. It was in this context that building materials were studied in detail, and this helped to understand their traditional use and conservation. This preparatory work was essential for a proper selection of repair materials.

## **SELECTIVE REMOVAL OF VEGETATION, MONITORING, AND DAMAGE RECORDING**

In order to understand the influence of vegetation on the earthen structures, it was decided to select one area that was overgrown with vegetation. This was regularly cleaned from all plants and grass and photographs were taken to monitor vegetation growth. This data was compared to that of a similar neighbouring structure that was left untouched.

## **SPOIL HEAPS REMOVAL**

Removal of spoil heaps was carried out in 2006 by hand and with light machinery. This work was supervised by an archaeologist to help with the identification of the spoil heaps to be removed.

## ANALYTICAL WORK

The aim of the present work was to provide information on the building materials of the Buddhist monastery. It is important to stress the extent to which the experimental analysis in this work and the information provided by the archaeologists and by the study of building techniques are complementary rather than one type of information being superior to the other. Just as the information provided by building archaeology is often incomplete, laboratory analysis does not provide the necessary data on the craftsmanship involved in traditional construction. An interdisciplinary approach is therefore clearly necessary for this type of research. This was done in different levels, the main queries being the following: comparison between mud brick sizes, study of building techniques (including *pakhsa*), laboratory analysis of historic building materials and comparison of wall masses, laboratory analysis and assessment of materials employed for the building of the shelter coat, analysis of natural samples surrounding the monastery area in order to understand the origin of the material used for the construction of the structure itself, study and assessment of material to be employed for the future repair of the monastery.

Careful examination of the archaeological structures often shows different layers and re-use of old mortars or renders included in the historic mix. Sampling was therefore preceded by visual inspection, which is a necessary tool for understanding and identifying the historic fabric and for carefully choosing the samples. In all cases samples were representative of the wall mass or structure under study. It was also important that sample collection was carried out without seriously damaging the historic fabric.

## RESULTS OF LABORATORY ANALYSIS

All analytical studies were undertaken following precisely the protocols explained by Fodde (2007b), hence it seems not necessary to repeat the methods here. A total of 20 historic samples of mud brick and 20 historic samples of *pakhsa* were analysed, and the averaged results provided here. Soluble salts were found in concentration of 3.7% for mud brick and 6.6% for *pakhsa*. Such difference of content between mud brick and *pakhsa* could not be explained as the material used for their manufacturing seems to be similar in origin (see granulometry areas, Fig 8). This similarity is also confirmed by the comparison of their mineral composition that was studied with XRD by Saitama University. Generally speaking the analysed population of samples shows high salinity, comparatively to other sites such as those in the Chuy valley (Kyrgyzstan), where it was calculated that for the sites of Krasnaya Rechka, Burana, and Ak Beshim the average soluble salts content is 3.8% (Fodde, Watanabe and Fujii 2008). As for other Central Asian sites such as Otrar (Kazakhstan), the average salts content of earthen materials is 5.6%. Carbonates were found in all of the tested samples from Ajina Tepa and the average value is 24.7% for mud brick and 24.6% for *pakhsa*. The conjecture is that the predominant acid-soluble element of the tested samples is calcium carbonate, but this is not supported by experimental analysis. The particle size distribution test for mud brick is: clay (14.7%), silt (64.9%), sand (19.9%), and gravel (0.5%), in contrast to the Particle size distribution test for *pakhsa* gave which is: clay (14.2%), silt (57.3%), sand (26.1%), and gravel (2.4%).

Physical tests were carried out for comparing the behaviour of historic samples to that of the possible repair material. The erosion test showed that the average perforation time for mud brick samples is 0:19 minutes and for *pakhsa* samples is 0:13 minutes. The wetting and drying test gave the average percentage of lost material after the fifth cycle for mud brick as being 9.8%, whilst for *pakhsa* samples is 7.0%. The shrinkage test provided a clear difference between mud brick (3.1%) and *pakhsa* (2.4%). A freeze and thaw test could not be carried out due to lack of freezing equipment in the project house.

Reference areas were calculated for both mud brick and *pakhsa*, showing a slight difference between the two (Fig 8), being the latter grading envelope wider and showing the flexibility of the construction method in terms of type of soil to be used. The two reference areas were useful for comparing the granulometry curves of possible repair materials. Testing with more sophisticated equipment was carried out at Saitama University, Japan. Tests included mineralogical composition of soil, x-ray diffractometry, and soluble salts composition.

The problem faced by the conservator of earthen buildings and sites today is that of selecting a repair material that follows the requirements given in the ICOMOS charters such as that for the Protection and Management of the Archaeological Heritage (1990). These include sacrificiality of repair interventions, reversibility, minimal intervention, repair like with like, etc. In order to achieve this fundamental aim, a sophisticated understanding of the materiality of the object or structure to be conserved is needed. Conservation papers that explain analytical work give no scientific explanation as whether the actual repair material will follow the requirements given by the ICOMOS charters. A new method was proposed by Fodde (2007b) for the requirement of sacrificiality, but more work needs to be done. The method was outlined with a simple field laboratory and it is planned to repeat it with more sophisticated analysis.

#### **CONSTRUCTION AND MONITORING OF TEST WALLS**

Eight test walls were built in the project house yard, following the method already carried out in Kyrgyzstan<sup>5</sup> (Fig 9). Test walls, measuring 120 x 120 x 38 cm (height, width, depth), were constructed with mud brick (measuring 34 x 16 x 10cm). The test wall construction follows the philosophical principle that suggests that testing of conservation materials should not be carried out on historic fabric. Test wall construction is dictated by the necessity of studying the best-performing material for the conservation of the site. This will be essential for testing the repair material after proper analysis in the laboratory. Monitoring of wall decay will be designed to record the following parameters: colour change, erosion, cross sections documentation, coving (undercutting), moisture, photographic documentation, extent of cracks, and weather. The data will be recorded after 3, 6, 12, and 24 months from the construction date of walls.

#### **DOCUMENTATION**

Extensive documentation work and training was carried out since the very beginning of the project: training in listing and archiving of documents, analysing and evaluating archival photos of structures (relevant to conservation), analysing and evaluating excavation reports (relevant to conservation), cataloguing and listing of objects and finds, topographical surveying,

purchasing of satellite image, archaeological investigation and site interpretation, 3D mapping and detailed study of important structures (sections and rectified elevations).

It should be also noted that the building techniques of the present masses of Ajina Tepe cannot be studied properly because of serious erosion and decay. Identification of mud brick and pakhsa is difficult and, in order to guarantee future repair and reconstruction of missing parts, it was decided to study the archival elevations and photographs left by Litvinskij. Trainees started producing axonometric drawings of masses so that to guarantee proper legibility of construction techniques and be a reference tool for the conservation work. This method was employed at the beginning of the project, but it was slowly abandoned because too time consuming.

### **THREE DIMENSIONAL DOCUMENTATION OF EARTHEN MASSES**

The photogrammetric documentation (both analogue and digital) of elevations was undertaken before, during, and after conservation. The method employed, 3D visualization of masses from digital stereo photographs, was of great use to the project. A topographical map of the site was also constructed by using photogrammetry together with total station recording (ground surface measuring equipment) (see Fig. 3).

### **DESIGNING PROFORMAS FOR CONDITION RECORDING**

Structures were studied with drawing conventions for damage assessment, authentication, and intervention record (Fig. 10 and 11). The conventions were designed following work already carried out in other sites such as Otrar (Kazakhstan), Krasnaya Rechka (Kyrgyzstan), and Mohenjo-Daro (Pakistan) (Fodde 2007c; Fodde 2008c). This essential tool was accompanied by a sketching sheet and by a bullet-point sheet to be used as a guide for the completion of proformas. The structure of the form is based on the following subjects: description of the object, examination of historic documents (photographs, archival material, etc.), previous interventions, summary of damage report (with reference to graphic material), diagnostic summary, intervention proposal, intervention action, recommendations for future monitoring and maintenance.

### **COLLECTION OF CLIMATIC DATA**

One of the future tasks for the project will be the creation of a computer database of old and new weather station data, and the interpretation of data (hopefully involving the weather station department of Kurgan Tybe). In this respect the following data is of prime importance:

- 1) diurnal max and min temperature (this provides information on expansion and contraction of materials, efflorescence, subflorescence, hygroscopicity of salts, evaporation rate).
- 2) diurnal maximum and minimum relative humidity (this provides information on: evaporation rate, hygroscopicity, increase in weight of structures, wetting and drying cycles, efflorescence and subflorescence phenomena).

- 3) rain fall data (this provides information on: erosion of wall surfaces, ground erosion, gullies, underground tunnels, holes, increase in weight of the wall and eventual bulging, wetting and drying cycles, settlement of lower parts that may create cracks and eventual wall collapse).

#### **GEOLOGICAL SURVEY**

A geological survey of two inspection wells of 10 metres depth was not yet carried out, but it will be undertaken to provide the following data: description of geological stratification, ground water level, and future possibility of monitoring of seasonal changes.

#### **CONSERVATION ACTIVITIES**

##### **CLEANING WORK AND TEMPORARY CONSERVATION**

Before undertaking any conservation activity, those walls that were covered in debris were inspected by the archaeological team. Cleaning was undertaken by removing the debris that covered the earthen structures to check the extent of walls. When full conservation could not be achieved before the winter, structures were temporarily conserved by backfilling until the next favourable season.

##### **REBURIAL ACTIVITIES**

One urgent conservation activity in Ajina Tepa is the reburial of some endangered structures. The first important suggestion is that any reburial activity should be preceded by the identification of appropriate materials and their sourcing. Employing local sand and soil in repair work has many advantages, not least of which is the fact that the sources for the original materials were traditionally close to the site. Reburial should be ensured after proper testing, cleaning, documentation, collection of information on the structures (coursing details, material analysis), application of separation layer, and design of monitoring programme. During excavation reburial was never contemplated as a conservation measure in Ajina Tepa. This is similar to what has been experienced in other countries; as such, proper awareness and training is necessary to make the technique acceptable ethically and to avoid psychological barriers.

##### **MONITORING CONSERVATION WORK**

Monitoring of conservation work will be done after designing a scheme that allows repeatability of methods. This could include insertion of plastic pins in the conservation work to measure erosion, and laboratory analysis of conservation material to measure eventual migration of salts (to be carried out by collecting samples vertically at given intervals so that to measure moisture and salts content). Furthermore, useful information on the behaviour of conservation work is provided by visual inspection of regular photographic documentation.

## **REPAIR OF ERODED WALLS AND SHELTER COATING**

Manufacturing of mud bricks for conservation started as soon as the selection of repair material was concluded in the field laboratory. Conservation work was concentrated in the monastery area where the most endangered structures are located (Figs. 12-17). The first area to be tackled was corridor III and V. Here archaeological cleaning was carried out under the supervision of an archaeologist. The main aim here was to consolidate structurally the wall between corridor III and VII-VIII. The shelter coat was applied following specific stages. The first was the preparation of the ground in terms of drainage so rain water would not reach the base of walls, and this was ensured by providing drainage slopes. Then a shallow trench (20cm deep) was dug along the wall and filled with a conglomerate of gravel and salts-free soil. The mix was rammed in as foundation measure, to give a solid ground on which to lay the shelter coat masonry. No geofabric was employed as a separation layer between the historic structures and the shelter coat because in Tajikistan there is a strong bias against such material: it is felt that it could emphasize rising damp and that its future use would be too expensive for any local project. Hence the construction of the shelter coat followed without separation layer; however, the mud bricks employed are clearly legible as a modern intervention. Filling of the gap between the mud brick skin and the historic fabric was carried out with dry soil. Plastering of the encapsulation with a mix of soil and straw then followed. In some cases windows were left so that to expose the historic fabric as a didactical approach to the shelter coating. This method was successfully employed in another UNESCO project: 'Preservation of Silk Roads Sites in the Upper Chuy Valley in Kyrgyzstan' (Fodde 2008b).

## **BUTTRESS CONSTRUCTION**

Some of the leaning walls were so endangered that it was necessary to build mud-brick buttresses to avoid total collapse of the historic fabric (Figs. 18 and 19). This was done as urgent conservation measure before shelter coating the wall.

## **MAINTENANCE ACTIVITY AFTER THE UNFAVOURABLE 'RAINY SEASON' SEASON**

This is to be considered as routine work for the proper conservation of the site. It is expected that after the rainy season ends, not only the historic parts, but also the conservation work may need maintenance. It is therefore suggested to allocate a budget for the yearly maintenance of the site and this should be carried out also after completion of the project. This should include also landscaping work and terrain modelling.

## **CONCLUSION**

Several benefits of the work to the site can be identified. Urgent conservation was tackled immediately and this included the repair of heavily eroded and tilting structures. More routine repair work was also carried out where needed. Site presentation was improved in terms of fencing, access bridge design and construction, and improvement of path. It should be also mentioned that documentation was extended to the entire site before and after conservation

so that to be used as a reference by future conservators. Follow up work will include maintenance schedules of both historic parts and repair work.

Apart from carrying out documentation and physical conservation at the site, another important outcome of the project was the improvement of skills of Tajik experts and the building up of a national capacity for the conservation and management of earthen archaeological sites. This is of great importance to Tajikistan especially when considering the shortage of skills that resulted after its independence from the ex USSR and the following civil war, when the majority of heritage experts fled the country. In addition, the country still lacks of appropriate infrastructure and conservation institutes or department, although recently the Tajik government has started to move to address this situation.

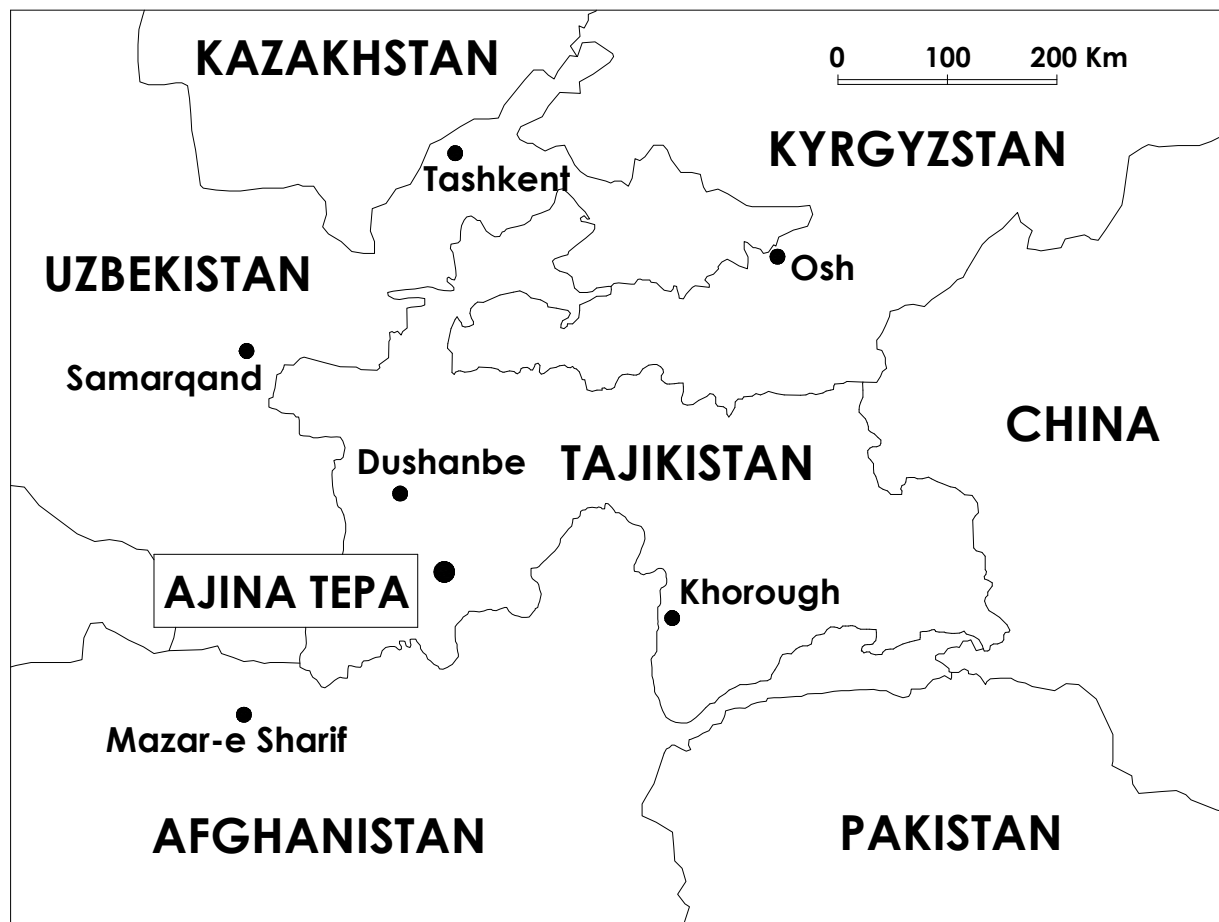


Fig 1: Map of Tajikistan showing location of Ajina Tapa and capital Dushanbe. (Picture: Enrico Fodde).



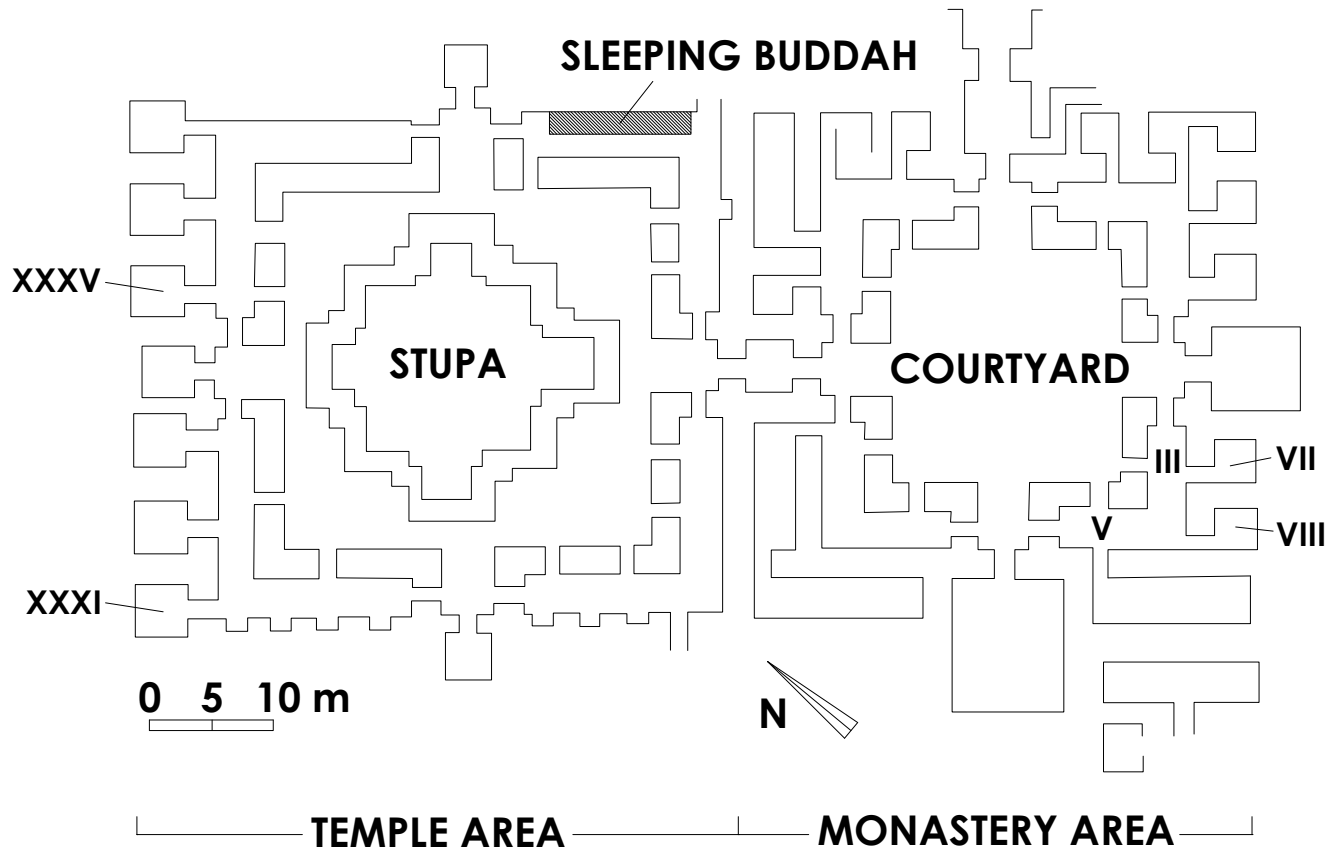


Fig 2: Schematic plan of the monastery of Ajina Tapa after Litvinskij and Zejmal (2004, 20) with numbering of points discussed in this paper. The plan shows the clear division between temple and monastery area, and the location of the sleeping Buddah (see Fig 4). The temple area is characterized by a 6m high stupa that is surrounded by four elbow-shaped passages (*īwān*). On the left hand side are a series of cellae where clay miniature versions of the stupa were found. The monastery area has a large courtyard that is surrounded by four *īwān* and by the monks rooms. The plan is characterised by thick walls (up to 2.4m) that were decorated with wall paintings and sculptures of the Buddha and bodhisattvas, now kept in the National Museum of Tajikistan. The plan of the second storey was not documented as it was not preserved.

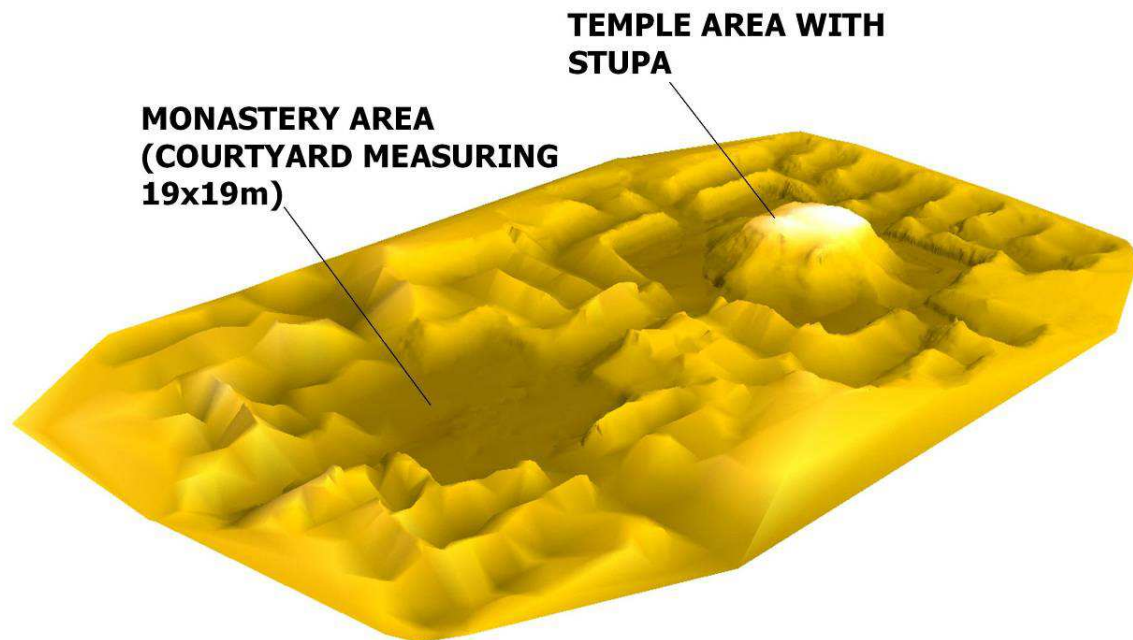


Fig 3: Three dimensional recording of the site from east showing elevated monastic area on the left (with courtyard) and temple area on the right (with elevated stupa). The overall shape of the plan is rectangular, measuring 50x100m. Picture showing documentation work in progress as carried out by Yukiyasu Fujii and Kunio Watanabe, 2007.



Fig 4: The 13 metre sleeping Buddha after conservation as displayed in the National Museum of Antiquities in Dushanbe, 2005. (Picture: Yuri Peshkov).





Fig 5: Growth of deep-rooted thick vegetation on and around historic earthen walls was one of the main threats for the preservation of the site (2005). Collapse of wall parts can take place when deep rooted shrubs increase in size. (Picture: Enrico Fodde).



Fig 6: Picture showing some of the decay patterns of the earthen walls of Ajina Tepa: coving at the wall base, erosion from top, and animal damage. (Picture: Yukiyasu Fujii).





Fig 7: Soluble salts crystallization is typical in central Asian sites. In Ajina Tepa the phenomenon is increased because the site is currently surrounded by a system of cotton fields that receive regular irrigation. The fields are about one metre higher than the floor of the site. Furthermore, an irrigation canal was built in Soviet time next to the site at a depth of about two metres from the cotton field (Picture: Enrico Fodde).

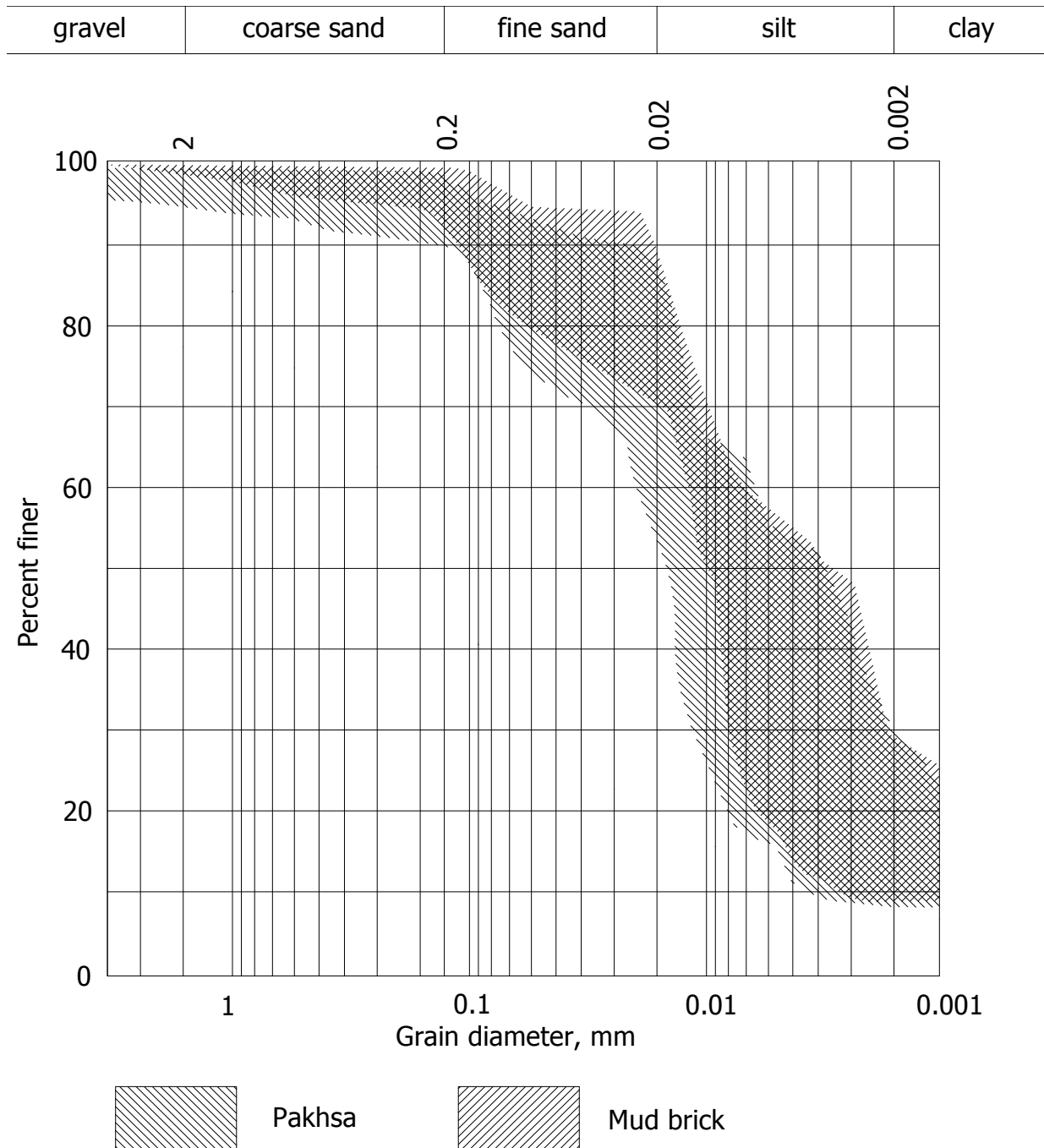


Fig 8: Diagram showing grading envelope or reference area for historic *pakhsa* and mud brick. The usefulness of a recommended zone derives from the fact that those soils which comply with it are more likely to behave satisfactorily than those which do not. The employment of this guidance zone is of great use especially for comparing it with the granulometry curves of the repair materials. Comparison between the two reference areas reveals a slight difference between range of soils employed in *pakhsa* and in mud brick. (Picture: Enrico Fodde).





Fig 9: Mud brick test walls were constructed with different plasters in order to study their long term response to the elements. This technique was employed for avoiding the testing of conservation materials on the historic fabric (2006). (Picture: Enrico Fodde).



## Drawing Convention

№	Symbol	Description (English)	Description (Russian)
1		Grass	Травянистые растения с коротким корнем
2		Grass with deep roots	Растения с длинным корнем
3		Hole (made by animals)	Большие норы
4		Hole (made by insects)	Норки насекомых
5		Wide portion of missing wall	Пещерообразное углубление
6		Hard crust of clay	Корковый оплыв
7		Soft crust of clay	Рыхлый оплыв
8		Crack	Трещины
9		Border between historic material and repair work	Граница между древней и консервационной стеной
10		Rising damp	Сырые участки
11		Geotextile	Геотекстиль
12		Salt crystallization	Высолы
13		Man-made damage	Человеческий фактор
14		Decayed mortar	Разрушение кладочного раствора
15		Flaking (mud brick)	Отслоение поверхности
16		Lichens	Лишайник
17		Decayed repair brickwork	Разрушение консервационной кладки

№	Symbol	Description (English)	Description (Russian)
18		Fired brick	Обожженный кирпич
19		Mud brick	Сырцовый кирпич
20		Replaced mud brick	Консервационный сырцовый кирпич
21		Missing mud mortar	Сохранившийся древний раствор
22		Referential channels	След от стока воды
23		Graffiti	Современные надписи на кирпиче
24		Cultural layer	Культурный слой
25		New mud plaster	Консервационная обмазка
26		Charcoal	Кусочки древесной золы
27		Carbonates	Карбонаты
28		Crushed fired brick	Цемянка
29		Coving	Рюмочное разрушение
30		Mud brick sample	Отбор проб кирпича
31		Mud mortar sample	Отбор проб раствора
32		Collection of debris at base of wall	Насыпь
33		Infill sand layer	Консервационный песок
34		Decayed repair plaster	Разрушение консервационной обмазки

Fig 10: Drawing conventions in English and Russian as employed for the documentation of damage and main conservation threats, see following picture, 2006. (Picture: Enrico Fodde).

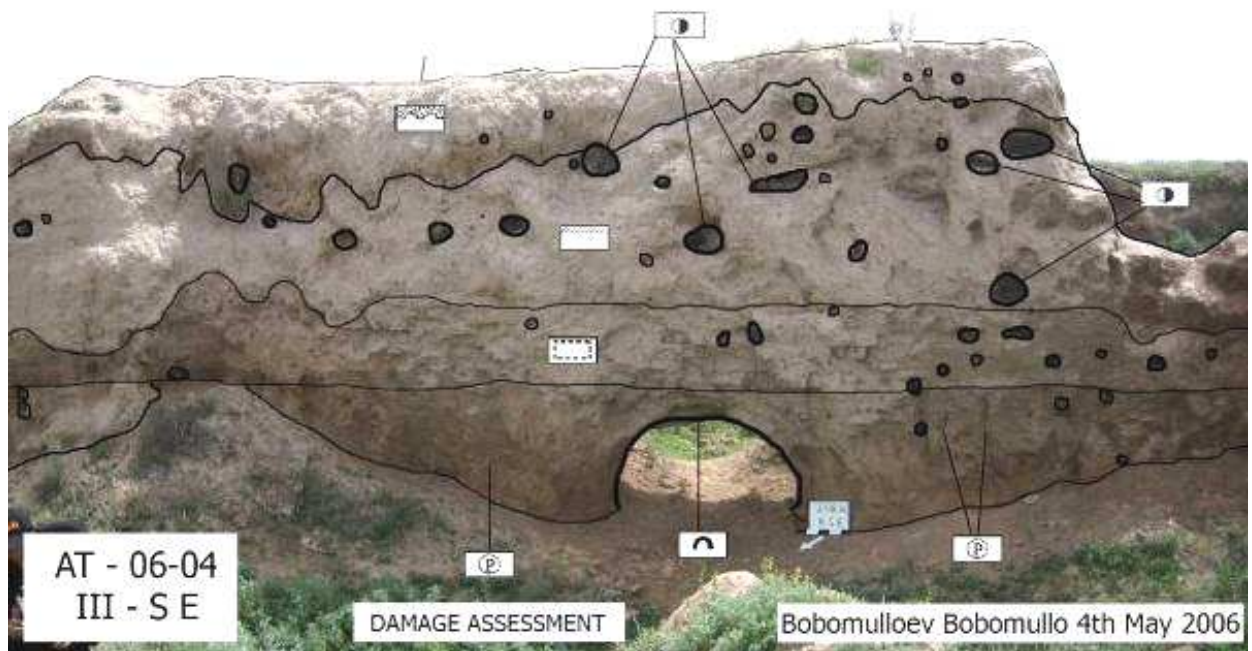


Fig 11: Picture showing documentation of damage assessment (2006). Symbols refer to the drawing conventions described in the previous picture. Every picture of damage assessment was added with the following information (from left to right): date, name of the structure, and name of trainee who undertook the survey (Picture: Enrico Fodde).



Fig 12: The most endangered walls were conserved by applying a shelter coat made of mud brick. This picture shows local master builders and labourers that were trained during the project (2007). Due to the height of some of some of the walls, shelter coats had to be made quite thick at the base. The rationale behind the design of this conservation intervention was that the historic structure would carry the minimum load and that the coat would be self supporting (Picture: Enrico Fodde).





Fig 13: Picture showing work progress relatively to Figs 11 and 12. (Picture: Kunio Watanabe).



Fig 14: Shelter coating followed the morphology of the earthen walls and in some cases windows were left to expose the original fabric a didactic guide to the work done. (Picture: Malika Budanaeva, 2007).



Figs 15, 16, 17: View of areas III and V from the monastery courtyard. Illustrations showing sequence of encapsulation work: portion of the monastery before cleaning of grass, after cleaning, and after application of shelter coating (2005-2008). The tall wall on the left hand side is the one illustrated in Figs 11, 12, and 13. (Pictures 15 and 16: Enrico Fodde. Picture 17: Yuri Peshkov).





Fig 18: Structural consolidation of leaning walls was undertaken with thick mud brick buttresses that have the advantage of being reversible and easily readable as a new intervention (2006). Illustration showing work in progress (Picture: Enrico Fodde).



Fig 19: Detail of previous picture showing relationship between mud brick buttress (under construction) and historic earthen wall (right). In order to have reversible interventions the buttress was built without inserting any bricks into the historic fabric, but by making sure that the connection was well packed with dry soil (2006). (Picture: Enrico Fodde).



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<sup>1</sup> One striking example is the pre-Islamic earthen city of Penjikent that is located between Samarkand and Ainy in north-west Tajikistan. Two thirds of the site (about 23 hectares) were extensively excavated since 1946 without providing any conservation to the structures, with the result that now the exposed city is fading away. Another recent approach to conservation in Tajikistan is that of ‘fantasy’ reconstruction, such as what done recently in Qhulbuk (9th to 11th century AD) where the citadel’s portal and walls were heavily reconstructed. As a result, both sites Penjikent and Qhulbuk were inscribed in the Heritage at Risk list, see Turekulova and Turekulov (2005).

<sup>2</sup> The renovation work undertaken includes: construction of kitchen; construction of traditional *iwan* (veranda for dining); construction of shelter for instruments; construction of lavatories; completion of boundary wall construction; renovation of house rooms to be used as accommodation for the experts; provision of 220 W electricity to the house; provision of hand pump and well to the house.

<sup>3</sup> The list of equipment purchased is: Munsell soil colour chart®, rubber headed pestle, liquid limit device, shrinkage mould, chloride test strips, sulphate test strips, sodium hexametaphosphate, soil hydrometer, 1000ml cylinders and rubber bungs, sieve shaker, sieves (4.0mm, 2.0mm, 1.18mm, 600 microns, 300 microns, 150 microns, 90 microns, 63 microns, lid, receiver), brass & nylon bristle sieve brush, spatula, timer clock, oven 80 litres, heat resistant gloves, trimming knife, digital pH/temp/mV meter, buffer solution for pH, wall mounted weather station, ceramic mortar, ceramic pestle, portable thermometer, balance with 0.01gr accuracy, knife for sampling, scalpel for sampling, glass rods 7mm dia, measuring cylinders 100ml, glass beakers (900ml, 600ml, 250ml, 100ml), polythene funnels 150mm dia, twigs for sampling (200mm, 150mm), petri dishes, filter papers, glass bottles for acids, pipette for drop test, magnifying glass.

<sup>4</sup> In Central Asia both rammed earth and cob are known as *pakhsa*. Such techniques were employed since pre-Muslim time, but they are less ancient than mud brick. In contemporary Central Asia both techniques are nowadays mostly employed in rural areas, but mud brick is also present in urban areas. *Pakhsa* was often built in juxtaposition with mud brick and in some cases the two were combined in alternate layers. Such stratification was common in the Sogdian site of Kizil Kir (1<sup>st</sup> century BC) where thick walls of 2.2-2.4m were built with *pakhsa* blocks measuring 50-55cm in height between which one course of mud brick (44x44x11-12cm) was inserted. Similar construction patterns were found in Jumalakteppa and in the Kashadarya castle of Aulteppe where two courses of mud brick were inserted. Ziablin (1961, 29) provides a description of the construction techniques of the second Buddhist temple of Ak Beshim, now entirely decayed after excavation: ‘Walls of the second Buddhist temple were made of a combination of *pakhsa* and mud brick. *Pakhsa* was made by ramming local soil in formwork. This technique was found at footing level, and alternate use of one rammed earth lift and three courses of mud brick was the rule. Vertical joints (3-4 cm thick) are alternated to form a stretcher bond between blocks, and this provides evidence that the *pakhsa* walls are made of rammed earth and not cob’. The reason for employing such technique may be double: levelling of the *pakhsa*

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work after every lift, and reducing shrinkage cracks upon drying. Generally speaking after the 1st century AD *pakhsa* walls became thinner, showing a more rational approach to the material (see Tolstov 1953; see also Nilsen 1966). Only defensive walls were more than 2m thick. The city walls of Qhulbuk (Tajikistan) for instance, dating 9th to 11th century AD, are eight metres thick at the base and were originally clad with a skin of fired brick.

<sup>5</sup> See what carried out in Fodde (2007b). Walls were built in the yard of the Project House, about 300 m from the site of Ajina Tapa. The area was cleared from all vegetation, after which it was made flat. Trenches (15 cm deep) were excavated so that to guest a foundation made of a conglomerate of soil and gravel that worked as separation layer between the virgin soil and the first course of mud brick. Eight test walls were aligned on the north-south axis so that to have their four sides exposed to the cardinal points. All mud bricks and mud mortar employed in the test walls are made with repair material N2 that was selected after analytical investigation:

TW 1: mud brick wall without plaster or capping.

TW 2: mud brick wall with mud and rice chaff plaster (2:1). The clay for the plaster was collected in Tabakhchy, north-west of Ajina Tapa (sample name Plaster 1).

TW 3: mud brick wall with mud and rice chaff plaster (2:1). The clay for the plaster was collected in Zaminiau, Gulystrou Street (sample name Plaster 2).

TW 4: mud brick wall. This was backfilled so that to test the use of reburial techniques.

TW 5: mud brick wall plastered with mud and wheat (2:1). The clay for the plaster was collected in Tabakhchy, north-west of Ajina Tapa (sample name Plaster 1).

TW 6: mud brick wall plastered with mud and wheat straw (2:1). The clay for the plaster was collected in Zaminiau, Gulystrou Street (sample name Plaster 2).

TW 7: mud brick wall plastered with mud and rice chaff (2:1). Plaster made with soil N2.

TW 8: mud brick wall plastered with mud and wheat straw (2:1). Plaster made with soil N2.

In order to have horizontal coursing, bricks were made straight after completion of drying. Irregular bricks were made rectangular by cutting the excess material with an axe. This was a time consuming task, but it was necessary for having comparable walls of similar height and depth. After completion of test walls construction, both horizontal and vertical joints of TW 1 and TW 4 were pointed. The test walls to which plaster was applied were not pointed so that to allow proper keying of the coat to the fabric.